

REMARKS

Applicants thank the Examiner for the thorough consideration given the present application. Claims 1, 2, 5, 7-9, 11, 15, 16, 18-25, and 34-40 are currently being prosecuted. The Examiner is respectfully requested to reconsider his rejections in view of the amendments and remarks as set forth below.

Rejection Under 35 USC §102

Claims 1, 3, 5-9, 11, 15, 16, 26 and 29-33 stand rejected under 35 USC §103 as being anticipated by Smith et al. (U.S. Published Appl. 2003/0224595). This rejection is respectfully traversed.

In regard to claims 3, 4, 6, 26 and 29-33, this part of the rejection is rendered moot by the cancellation of these claims.

The Examiner points out that the Smith et al. teaches a method for forming a metal damascene structure including forming a cap layer over a copper layer, forming a dielectric layer over the cap layer, etching the dielectric layer and the underlying cap layer using reactive ion etching to form a damascene opening and expose the first metal layer, wherein impurities are formed on the exposed first metal layer and performing the plasma treatment on the exposed first metal layer to remove the impurities. The Examiner also points out that the plasma treatment utilizes a hydrogen or a hydrogen-containing plasma and an oxygen containing plasma.

Applicants submit that claim 1 as amended is not anticipated by or obvious over Smith et al. In particular, claim 1 has now been amended to specify that the plasma utilized contains nitrogen and oxygen. This is clearly not seen in Smith et al. Smith discloses a cleaning method for removing a side wall polymer from interconnect vias or trenches. The residue is removed by plasma containing about 60% hydrogen and about 40% argon, which is substantially free of nitrogen (see paragraph [0052]). This clearly teaches away from claim 1 which states that the plasma contains nitrogen and oxygen to remove the impurities. Accordingly, Applicants submit that claim 1 is not anticipated by this reference.

Claims 2, 7-9, 11-15 and 16 depend from claim 1 and as such are considered to be allowable. In addition, all of these claims recite other features of the invention which make them additionally allowable. For example, claims 2 and 5 relate specific components of the plasma.

Claims 1-4, 6-9, 11, 15, 16, 26 and 28-33 stand rejected under 35 USC §103 as being anticipated by Ngo et al. (U.S. Published Appl. 2002/0162736). This rejection is respectfully traversed.

In regard to claims 3, 4, 6, 26 and 28-33, this part of the rejection is rendered moot by the cancellation of these claims.

The Examiner states that Ngo et al. teach a method for forming a metal damascene structure including forming a cap layer on a metal

layer, forming a dielectric layer on the cap layer, etching the dielectric layer and the cap layer to form a damascene opening, wherein impurities are formed on the exposed first metal layer and performing a plasma treatment on the exposed first metal layer to remove the impurities. The plasma treatment uses hydrogen, a nitrogen plasma, an ammonia plasma and mixtures thereof.

Applicants submit that claim 1 as amended is neither anticipated by nor obvious over this reference. As noted above, in regard to the Smith et al. reference, claim 1 now specifies that the plasma contains nitrogen and oxygen. Ngo et al. also does not teach or suggest that the plasma uses nitrogen and oxygen. In view of this, Applicants submit that claim 1 is likewise not anticipated by Ngo et al.

Claims 2-16 depend from claim 1 and as such are also considered to be allowable. In addition, these claims recite other features of the invention which make these claims additionally allowable. As noted above, specifically, claims 2 and 5 recite other components of the plasma.

Rejection Under 35 USC §103

Claims 18-25 and 27 stand rejected under 35 USC §103 as being obvious by Smith et al. in view of Wu et al. (U.S. Published Appl. 2003/0022513). This rejection is respectfully traversed.

In regard to claim 27, this rejection is rendered moot by the cancellation of this claim.

The Examiner points out that Smith et al. teaches a method as described above. However, the Examiner admits that Smith et al. failed to teach that the reactive ion etching uses a fluorine-containing plasma or a chlorine-containing plasma. The Examiner relies on Wu et al. to teach the idea of etching using a fluorine-containing plasma. Applicants submit that claim 18 is not obvious over this combination of references.

Claim 18 includes a similar limitation to claim 1 that the plasma contains nitrogen and oxygen. As pointed out above, Smith et al. did not disclose this feature. Wu discloses a polymer debris pre-cleaning method where pre-cleaning is performed by plasma after an etching process. However, Wu does not teach or suggest that the plasma treatment is performed on the metal layer as recited in amended claim 18. Also, Wu does not teach that the plasma treatment is performed to remove impurities on the metal layer underlying the dielectrical layer and repair the binding between the metal layer and the dielectric layer thereby preventing dielectric peeling and passing the stress migration and electrical migration. Further, Applicants submit that the combination of Smith and Wu still fail to show the use of a plasma treating where the plasma contains nitrogen

and oxygen in order to remove impurities formed on the exposed first metal layer.

Applicants submit that the Examiner has not shown any motivation to combine the teachings of Smith and Wu. Since Smith teaches the removal of polymeric residue by a plasma substantially free of nitrogen and Wu discloses polymer debris removed by a plasma containing nitrogen, Applicants submit that it would not have been obvious to one skilled in the art to combine these two teachings. Accordingly, Applicants submit that claim 18 is allowable over this combination of references.

Claims 19-25 depend from claim 18 and as such are also considered to be allowable. In particular, since these claims recite other limitations of the invention, Applicants submit that these claims are additionally allowable. In particular, it is noted that claims 19 and 20 further recite components of the plasma.

Claims 34 and 36-40 stand rejected under 35 USC §103 as being obvious over Smith et al. in view of Huang (U.S. Published Appl. 2002/0054962). This rejection is respectfully traversed.

As noted above, Smith et al. teaches a method for forming a metal damascene structure. The Examiner admits that Smith et al. fails to teach that a resist to perform the patterning of the dielectric layer contains carbon. The Examiner relies on Huang to show the formation of an interconnect structure using organic photo

resists as part of the process. The Examiner feel that it would have been obvious to use a resist containing carbon as taught by Huang in this method process.

Claim 34 has been amended to recite that the plasma contains nitrogen and oxygen, in the same fashion as claims 1 and 18. As noted above, Smith et al. fails to show this feature. Huang shows a method to enhance adhesion and to minimize oxidation of carbon-containing layers by a plasma treatment where the treatment is performed following the deposition of the layer to be treated. Thus, Huang teaches that the plasma treatment is performed following the deposition of the layer to be treated rather than following the etching as currently recited in amended claim 34. Thus, Huang teaches away from the concept that the plasma treatment removes impurities on the metal layer and repairs the binding between the metal layer the dielectric layer to prevent dielectric peeling and passing the stress migration and electro migration.

Thus, Applicants submit that the combination of Smith et al. and Huang does not teach amended claim 34 and especially the use of a plasma nitrogen and oxygen to remove impurities formed on the exposed metal layer.

Furthermore, Applicants submit that the Examiner has not shown motivation to suggest the combination of Smith et al. and Huang. Smith teaches the removal of residue by a plasma substantially free

of nitrogen and Huang teaches a method to enhance adhesion by treating carbon-containing layers using a plasma containing nitrogen. Accordingly, it would not be obvious to one of ordinary skill in the art to combine these two teachings. Accordingly, Applicants submit that claim 34 is likewise allowable.

Claims 35-40 depend from claim 34 and as such are also considered to be allowable. In addition, these claims are additionally allowable since they contain other features of the invention. It is noted that claims 35 and 36 describe other components of the plasma.

Claim 35 stands rejected under 35 USC §103 as being obvious over Smith et al. in view of Huang and Wu et al. The Examiner relies on Wu et al. to show the use of a fluorine-containing plasma or a chlorine containing plasma. Applicants submit that claim 35 is allowable based on its dependency from allowable claim 34. Furthermore, Applicants submit that the combination of the three references still does not teach the use of a plasma containing nitrogen and oxygen as discussed above. Accordingly, Applicants submit that this rejection is likewise overcome.

Conclusion

In view of the above remarks, it is believed that the claims clearly distinguish over the patents relied on by the Examiner

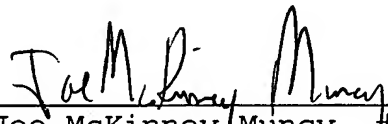
either alone or in combination. In view of this, reconsideration of the rejections and allowance of all the claims are respectfully requested.


Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Robert F. Gnuse (Reg. No. 27,295) at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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